FAA-E-2723
December 21, 1982

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

REMOTE (RADIO) CONTROL SYSTEM

1. SCOPE

1.1 Scope.- This specification contains requirements for a remote (radio) control system for operating and controlling airport visual aids systems from the airport control tower. The requirement is for a switch assembly cabinet, a switch assembly panel, an encoder interface unit, a transmitter, a receiver, and a decoder unit to interface with visual aids lighting control systems. The encoder shall be pushbutton actuated and installed in the airport control tower for modulating the transmitter frequency. The receiver and decoder units shall be installed in the proximity of each associated visual aids lighting control system.

1.2 Classification.- The remote control system shall have five types of switch assembly panels. The switch assembly panels shall have the following configurations:

Type I For controlling the medium intensity approach lighting system with runway alignment indicator lights (MALSR) (3.1.2(a))

Type II For controlling the omnidirectional approach lighting system (ODALS) (3.1.2(b))

Type III For controlling the runway end identifer lights (REIL) (3.1.2 (c))

Type IV For controlling the visual approach slope indicator system (VASI) (3.1.2(d))

Type V For controlling the emergency engine generators (3.1.2(e))

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The latest editions of the following FAA specifications and standards of the issues specified in the invitation for bids, or request for proposals, form a part of this specification, and are applicable to the extent specified herein.

2.1.1 FAA specifications

FAA-D-2494/1	Part I, Preparation of Manuscript, Technical Instruction Book Manuscript: Equipment and System Requirements
FAA-D-2494/2	Part II, Preparation of Reproducible Copy and Original Artwork
FAA-E-163	Racks, Cabinet and Open Frame Types
FAA-E-2663	Interface Unit, MALSR Remote Control
FAA-G-1210	Provisioning Technical Documentation
FAA-G-2100c	Electronic Equipment, General Requirements

2.1.2 FAA standards

FAA-STD-013	Quality Control Program Requirements
FAA-STD-021	Configuration Management (Contractor Requirements)

(Copies of FAA specifications and standards may be obtained from the Contracting Officer in the Federal Aviation Administration office issuing the invitation for bids or request for proposals. Requests should fully identify material desired, i.e., specifications, standards, amendments, and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contracts involved, or other use to be made of the requested material. All requests should be for the latest edition available.)

2.2 Military and Federal publications.- The following Military and Federal publications, of the issue in effect on the date of the invitation for bids or request for proposals, form a part of this specification, and are applicable to the extent specified herein.

2.2.1 Military specifications

MIL-P-15024	Plate, Tags, and Bands for Identification of Equipment

MIL-C-24308	Connector, Electric, Rectangular, Miniature Polarized Shell, Rack and Panel
MIL-E-17555	Electronic and Electrical Equipment, Accessories, and Repair parts, Packaging and Packing
MIL-I-46058	Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)
MIL-M-38510	Microcircuits, General Specification for
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-P-55110	Printed Wiring Boards

2.2.2 Military standards and publications

MIL-STD-242F	Electronic Equipment Parts, Selected Standards for RF and Acoustical Parts (Part I)
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-470	Maintainability Program Requirements (For Systems and Equipment)
MIL-STD-785	Requirements for Reliability Program (For Systems and Equipment)
MIL-STD-810	Environmental Test Methods
MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment
MIL-HDBK-472	Maintainability Predictions

(Single copies of military specifications, standards, and publications may be obtained from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, Pennsylvania 19120.)

2.2.3 FCC documents

FCC Rules and Regulations, Radio Frequency Devices, Part 15

FCC Rules and Regulations, Volume II, Part II

(Information on obtaining copies of FCC documents may be obtained from the FCC offices; 1114 21st NW., Washington, D.C. 20037.)

2.3 Industry standards.- The following industry standards of the issue in effect on the date of invitation for bids or request for proposals form a part of this specification.

2.3.1 Electronic Industries Association standards

EIA-STD-RS-152-B	Minimum Standards for Land Mobile Communications FM or PM Transmitters
EIA-STD-RS-204B	Minimum Standards for Land Mobile Communications FM or PM Receivers
NFPA No. 70	National Electrical Code

(Copies of EIA standards can be obtained from Electronic Industries Association, Engineering Department, 2001 Eye Street, NW., Washington, D.C. 20006; the National Electrical Code is available from National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110.)

2.3.2 American Iron and Steel Institute standard

AISI	Stain and Heat Resistant Steel, No. 13

(Copies can be obtained from American Iron and Steel Institute, 1000 16th Street, NW., Washington, D.C. 20036)

2.3.3 American National Standards Institute

ANSI C 62.1	Quantities and Units Used in Electricity

(Copies of ANSI standards can be obtained from the American National Standards Institute, 70 East 45th Street, New York, New York 10017)

2.3.4 National Telecommunications and Information Administration Documents

NTIA Manual	Regulations and Procedures for Federal Radio Frequency Management

(Information on obtaining copies of NTIA documents may be obtained from the NTIA offices; 14th and Constitution Avenue NW., Washington, D.C. 20230)

2.4 Precedence.- When conflict exists between the requirements of the contract and this specification, the contract shall take precedence. When conflict exists between the requirements of this specification and its referenced documents, this specification shall take precedence.

3. REQUIREMENTS

3.1 General.- The contractor shall provide all of the services and materials necessary to design, develop, fabricate, test, and deliver the equipments required by this specification and the contract. The contractor shall supply the major deliverable items specified herein in the quantities and at the times required by the contract. Any feature or item necessary to achieve the operation and performance required by this specification shall be incorporated or furnished even though such feature or item is not specifically defined or described herein. The contractor shall provide all services and materials necessary to prepare, reproduce, and provide engineering analyses, reports, instruction books, and other documentation as specified herein. The remote (radio) control system shall be designed to control visual aid systems from the air traffic control tower (ground-to-ground control). The remote (radio) control system shall be capable of controlling up to 15 different visual aid systems with up to 8 different status conditions for each visual aid system. A functional block diagram of the remote (radio) control system is shown in figure 1.

3.1.1 Equipment to be furnished by the contractor.- Each remote (radio) control system furnished by the contractor shall be complete and in accordance with all specification requirements, and shall include the items listed below. Quantities shall be as specified in the contract schedule.

(a) Switch assembly cabinet

(b) Switch assembly panel

(c) Encoder interface unit

(d) Transmitter

(e) Receiver

(f) Decoder

(g) Instruction books for the above equipment

(h) Site spare parts for each unit of equipment

3.1.2 Controlled facilities.- The remote (radio) control system is intended to be used to control the visual aid facility functions described below.

(a) MALSR, Medium intensity approach lighting system with runway alignment indicator lights shall be controlled as follows:

1 MALS OFF - Turns off the MALSR system

2 MALS 1 - Selects low intensity on visual aid system

3 MALS 2 - Selects medium intensity on visual aid system

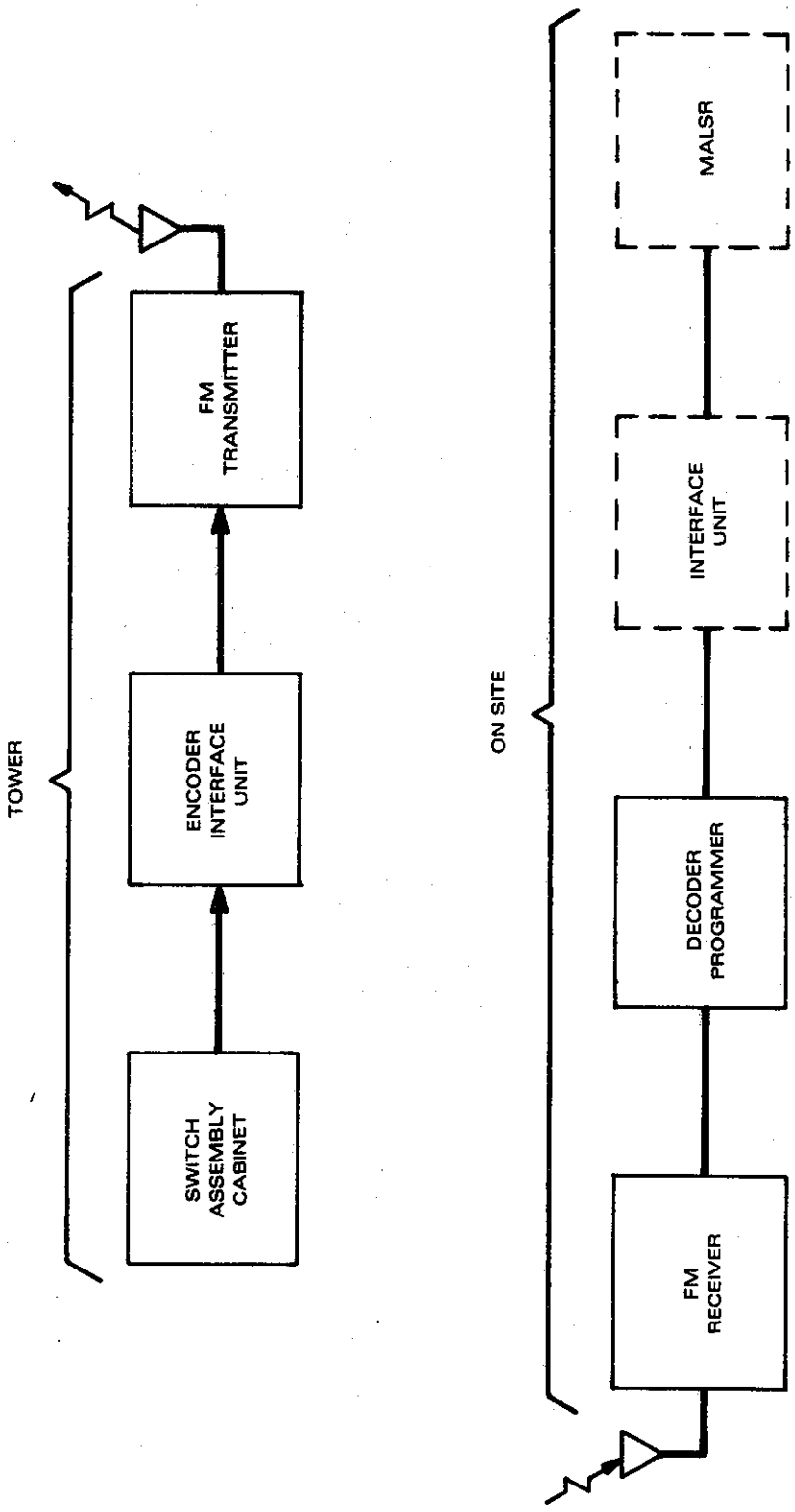

Figure 1. Radio Control System

4 MALS 3 - Selects high intensity on visual aid system

5 RAIL ON - Turns on sequenced flasher lights after they have been turned off (applies only when MALS system is turned on)

6 RAIL OFF - Turns off sequenced flasher lights after they have been turned on (applies to MALSR only)

7 A/G ON (air-to-ground enable)

8 G/G ON (ground-to-ground enable)

9 Lamp test/facility indicator

(b) ODALS, Omnidirectional approach lighting system shall be controlled as follows:

1 ODALS OFF - Turns off the ODALS system

2 ODALS 1 - Selects low intensity on visual aid system

3 ODALS 2 - Selects medium intensity on visual aid system

4 ODALS 3 - Selects high intensity on visual aid system

5 A/G ON (air-to-ground enable)

6 G/G ON (ground-to-ground enable)

7 Lamp test/facility indicator

(c) REIL, Runway end identifier lights shall be controlled as follows:

1 REIL OFF - Turns off the REIL system

2 REIL 1 - Selects low intensity on visual aid system

3 REIL 2 - Selects medium intensity on visual aid system

4 REIL 3 - Selects high intensity on visual aid system

5 A/G ON (air-to-ground enable)

6 G/G ON (ground-to-ground enable)

7 Lamp test/facility indicator

(d) VASI, Visual approach slope indicator system shall be controlled as follows:

1 VASI OFF - Turns off the VASI system

2 VASI ON - Turns on the VASI system

3 A/G ON (air-to-ground enable)

4 G/G ON (ground-to-ground enable)

5 Lamp test/facility indicator

(e) Emergency engine generators

1 VASI OFF - Turns off the emergency engine generators

2 VASI ON - Turns on the emergency engine generators

3 Lamp test/facility indicator

3.2 Equipment characteristics.- The remote (radio) control system shall be capable of operating and controlling visual aids lighting systems from the airport air traffic control tower, as indicated in figure 1.

3.2.1 Performance characteristics

3.2.1.1 Switch assembly cabinet.- A switch assembly cabinet with mounting facilities for holding five switch assembly panels and their encoder units shall be provided for mounting in the air traffic controller's console. The switch assembly panels for each facility shall be horizontally oriented as shown in figure 2. The switch assembly cabinet shall also contain a motherboard, a connector for connection of signals and power to the encoder interface unit, and a dimmer. The input power to the cabinet shall be 24 V dc unregulated.

3.2.1.1.1 Motherboard.- The motherboard shall have five receptacles that mate with plugs on the encoder units. The motherboard shall have a 12 V dc regulator for supplying power to five encoder units, and circuitry to select and transfer received signals from the encoder unit to the encoder interface unit. The light dimmer shall receive its power from the motherboard. Output signals from the motherboard shall be transferred to the encoder interface unit located in the equipment room via a 15-pin connector.

3.2.1.1.2 Connector.- The switch assembly cabinet shall be equipped with a 15-pin connector for transferring output signals to the encoder interface unit. Input power to the cabinet shall be received through the 15-pin connector. Pins 1 and 2 shall be assigned to the serial data signals; pins 3, 10, and 11 to the serial data control signals; and pins 7 and 14 to the input power (24 V dc unregulated). Pins 2, 4, 5, 6, 9, 12, 13, and 15 shall be spares. The connectors shall be M24308/1-2 for socket and M24308/3-2 for plug, and shall conform to MIL-C-24308.

3.2.1.1.3 Switch lighting control.- Each switch assembly cabinet shall be equipped with a dimmer for manually controlling the intensity of the lights in the pushbutton switches, from off to maximum. The intensity of a light shall not vary as a function of the number of lights illuminated.

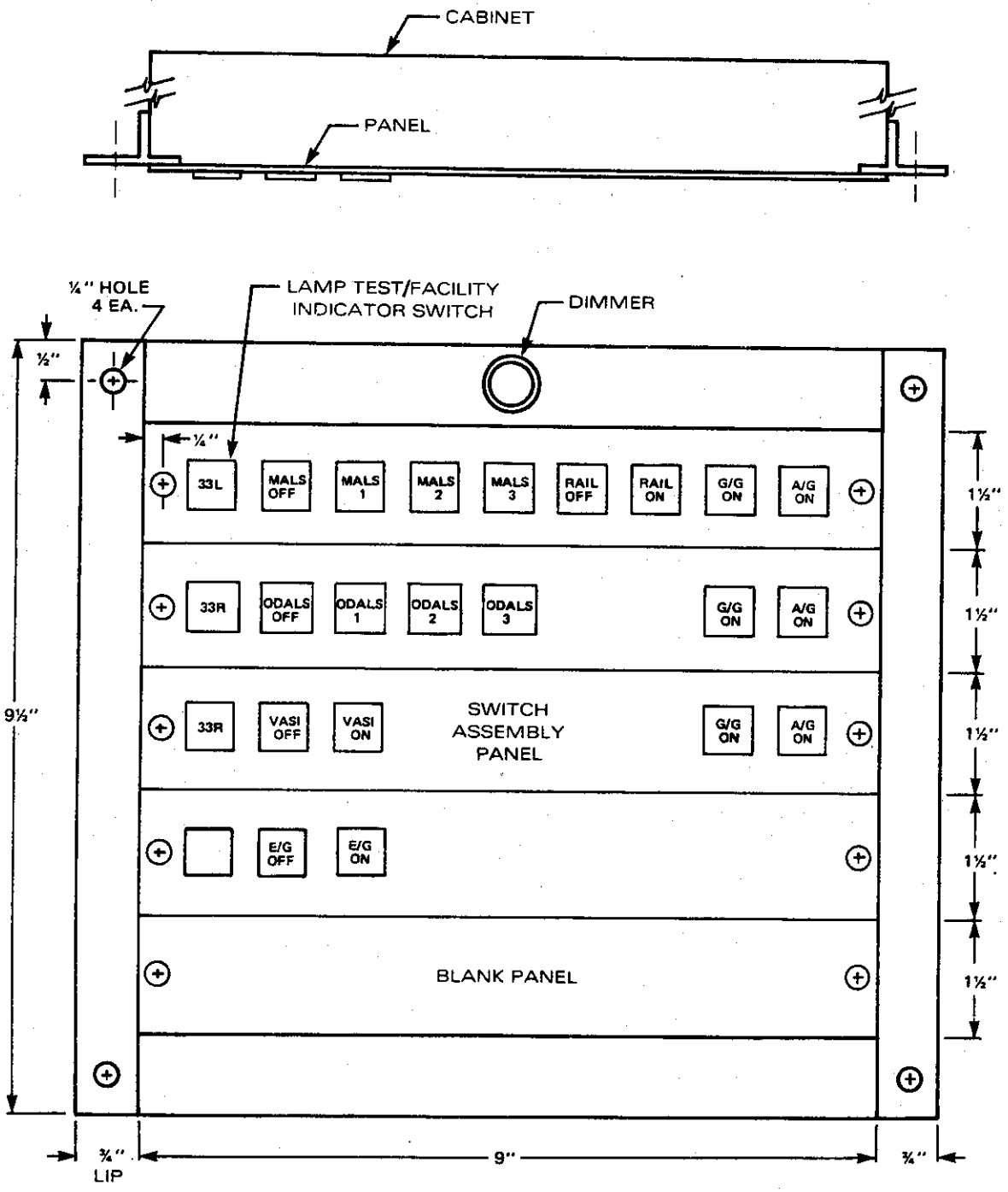

Figure 2. Switch Assembly Cabinet

3.2.1.2 Switch assembly panel.- The switch assembly panel shall contain pushbutton switches, and an encoder unit that interfaces with a motherboard in the switch assembly cabinet. The switch assembly cabinet shall accept five distinct switch assembly panel configurations. The Type I configuration shall be used for the MALSR lighting system. The panel shall feature three mechanically-latching interlocked switch assemblies, and one lamp-test/ facility indicator switch. One of the switch assemblies shall consist of MALS OFF and intensity levels 1, 2, and 3 pushbutton switches. The second switch assembly on the panel shall consist of RAIL OFF and RAIL ON pushbutton switches. The third switch assembly on the panel shall consist of G/G ON and A/G ON pushbutton switches. The Type II and Type III configurations shall be used for ODALS and REIL visual aid systems respectively. The panel shall feature two mechanically-latching interlocked switch assemblies and one lamp-test/facility indicator switch. The first switch assembly shall consist of a facility OFF pushbutton switch and intensity levels 1 through 3 pushbutton switches. The second switch assembly shall consist of G/G ON and A/G ON pushbutton switches. The Type IV configuration shall be used for the VASI lighting system. The panel shall feature two mechanically-latching interlocked switch assemblies and one lamp-test/facility indicator switch. One of the switch assemblies shall consist of VASI OFF and VASI ON pushbutton switches. The other switch assembly shall consist of G/G ON and A/G ON pushbutton switches. The Type V configuration shall be used for the emergency engine generator system. The panel shall feature one mechanically-latching interlocked switch assembly consisting of E/G ON and E/G OFF , and a lamp-test/facility indicator switch. Depression of any switch in a switch assembly shall release any other switch in the assembly. Figure 2 shows four possible panel configurations in a switch assembly cabinet. Each switch assembly panel shall be provided with a rigid frame for holding the encoder unit. The frame shall have a connector that mates with a receptacle on the motherboard. Each switch and switch assembly shall be fully assembled, wired, and connected to the encoder unit.

3.2.1.2.1 Pushbutton switches.- The actuation of a pushbutton switch on a switch assembly panel shall provide the command signal to the visual aid system being remotely controlled. Each pushbutton switch shall have an internal lamp that indicates the status of the facility being controlled. The lamp in the lamp-test/facility indicator switch shall be lighted whenever a pushbutton switch on the panel is actuated. Depression of the lamp-test/facility indicator switch shall cause all lamps in the pushbutton switches to illuminate. The pushbutton switches shall receive power from the motherboard via the encoder unit.

3.2.1.2.2 Interconnecting wiring.- The wires interconnecting the pushbutton switches with the encoder shall be no smaller than 22 gage each. Each conductor shall consist of stranded copper wire with color-coded polyvinyl chloride.

3.2.1.2.3 Encoder unit.- The encoder unit shall provide a unique serial data code for each signal received from a pushbutton switch actuation. The serial data code shall include a start code, a unique facility code, a unique function command code, and a stop code. The encoder unit shall interface with the motherboard in the switch assembly cabinet via a 15-pin connector, M24308/1-2 for socket and M24308/3-2 for plug, conforming to MIL-C-24308.

3.2.1.2.3.1 Reprograming.- The encoder unit shall be accessible to provide for assignment or reassignment of the facility code before signal encoding. The programing components shall be an integral part of the encoder unit. The function command code, corresponding to the actuation of a pushbutton on the switch assembly panel, shall be permanently programed as shown in figure 3 and table I.

3.2.1.2.3.2 Encoder unit inputs.- Switched signal inputs shall be provided to the encoder unit by the pushbutton switches. Input power to the encoder unit shall be supplied by the 12-volt regulator on the motherboard.

3.2.1.2.3.3 Encoder unit outputs.- The serial data code from the encoder unit to the motherboard shall consist of one pulse for the start code, five pulses for the facility code, eight pulses for the function command code, and one pulse for the stop code. The encoder unit outputs shall be complementary metal-oxide-semiconductor (CMOS) logic compatible (0 V, 12 V dc). Figure 3 shows the format of the serial data code.

3.2.1.2.3.4 Connector.- Connections from the encoder unit to the motherboard shall be through a 15-pin connector conforming to MIL-C-24308. Part numbers shall be M24308/1-2 for socket and M24308/3-2 for plug. Pins 1 and 9 shall be assigned to the serial data signals; pins 2, 10, and 11 to the serial data control signals; pins 4 and 5 to the encoder input power; and pins 8 and 15 to the pushbutton switches input power. Pins 10, 4, 5, 7, and 13 shall be spares.

3.2.1.3 Encoder interface unit.- Serial data signals from the switch assembly cabinet shall be received at the encoder interface unit via a 15-pin connector. The assignment of the pins shall be in accordance with 3.2.1.1.2. The interface unit shall accept signals from a maximum of three switch assembly cabinets. The serial data shall be used as keying signals to deliver tones of 2225 Hz and 2025 Hz, corresponding to mark and space frequencies, to the transmitter. The tone generator shall be an integral part of the encoder interface unit. The interface unit shall contain circuitry to turn the transmitter on prior to transmission and off at the conclusion of the transmission (asynchronous transmission). The interface unit shall be located in the equipment room which in turn shall be no more than 500 feet away from the switch assembly cabinet.

3.2.1.3.1 Power supply.- The encoder interface unit shall have a power supply that operates from a 120 ±18 V ac, 60 Hz primary power source. The power supply shall be designed to provide dc power requirement (24 V dc unregulated) to the switch assembly cabinet containing five MALSR switch assembly panels. In addition, the power supply shall provide dc input power to the encoder interface unit circuitry.

3.2.1.3.2 Interface unit output.- The interface unit shall sequentially deliver tones of 2025 Hz and 2225 Hz to modulate the transmitter carrier frequency. The modulation shall produce a minimum deviation of ±3 kHz of the fm carrier (equivalent to 100 percent modulation in the 162 to 174 MHz band).

3.2.1.3.3 Connector.- Signals from the interface unit shall be transferred to the transmitter via a 9-pin connector. Pins 1 and 6 shall be assigned to the serial data signals and pins 5 and 9 to the transmitter control signals. The remaining pins shall be spares. The connector shall conform to MIL-C-24308. Part numbers shall be M24308/1-2 for socket and M24308/3-2 for plug.

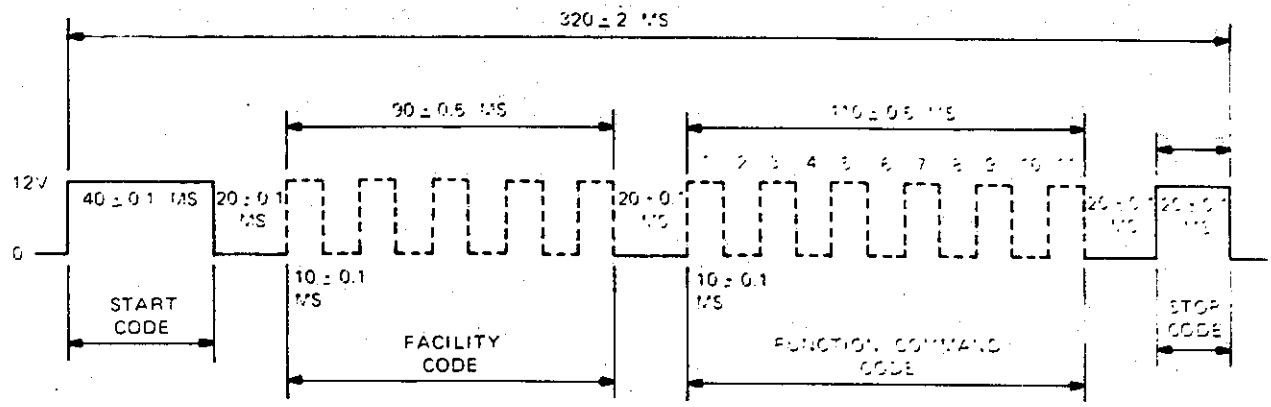

Figure 3. Serial Data Code Format

Table I. Function Command Code Format

Function Command		Function Command Code (See figure 3)										
		1	2	3	4	5	6	7	8	9	10	11
Intensity levels	Off	⊓	_	_	_	_	_	_	_	_	_	_
	On	_	⊓	_	_	_	_	_	_	_	_	_
	1	_	_	⊓	_	_	_	_	_	_	_	_
	2	_	_	_	⊓	_	_	_	_	_	_	_
	3	_	_	_	_	⊓	_	_	_	_	_	_
	G/G ON	_	_	_	_	_	_	_	_	_	⊓	_
	A/G ON	_	_	_	_	_	_	_	_	_	_	⊓
	RAIL ON	_	_	_	_	_	⊓	_	_	_	_	_
	RAIL OFF	_	_	_	_	_	_	⊓	_	_	_	_

3.2.1.4 Frequency modulated (fm) transmitter.- The fm transmitter shall provide crystal-controlled single channel operation in the 162 to 174 MHz frequency band. The transmitter shall be capable of providing a radio frequency power output, adjustable from 1 to 2.5 watts, into an output impedance of 50 ohms.

3.2.1.4.1 Spurious and harmonic emissions.- Conducted spurious and harmonic emissions shall be no greater than 50 microwatt or more than 43 dB + 10 log (power) dB below carrier.

3.2.1.4.2 Frequency stability.- The carrier frequency shall be maintained within ±0.0005 percent of the reference frequency in ambient temperatures ranging from -40° C to +60° C and ±0.0005 percent with a 20 percent primary voltage deviation.

3.2.1.4.3 Modulation.- Type 15 F2 modulation as specified in FCC Rules and Regulations, Volume II, Part II, shall provide ±3 kHz deviation for 100 percent modulation in the 162 to 174 MHz band.

3.2.1.4.4 Audio sensitivity (3 kHz deviation).- The audio sensitivity shall be 0.120 V, ±3 dB for 3.0 kHz deviation at 1000 Hz.

3.2.1.4.5 FM noise level.- The frequency modulated noise level shall be as follows:

Power supply fundamental operating frequency	FM noise level ±3 kHz deviation
Below 200 Hz	35 dB

3.2.1.4.6 Audio distortion.- The audio distortion shall be less than 3 percent at 1000 Hz for ±3 kHz deviation.

3.2.1.4.7 Audio frequency response.- From 300 to 3000 Hz, the audio frequency response shall not vary more than +1 dB or -3 dB from a true 6 dB per octave preemphasis characteristic as referred to the 1000 Hz level.

3.2.1.4.8 Modulation limiting.- The instantaneous peak and steady-state deviations shall not exceed ±3 kHz deviation at any audio frequency in the temperature range between -30° C and +60° C.

3.2.1.4.9 Temperature range.- The power output shall not be degraded more than 3 dB below the output obtained under standard test conditions.

3.2.1.4.10 Transmitter attack time.- The carrier level shall increase to 90 percent of its maximum peak prior to the transmission of the serial data code.

3.2.1.4.11 Power source.- The transmitter shall be equipped with an integral power supply operating from 120 ±18 V ac, 60 Hz, meeting the requirements of FAA-G-2100c, paragraph 3.3.2.4.

3.2.1.5 Antenna.- The transmitting and receiving antennas shall each be a standard quarter-wave vhf whip antenna for the 162 to 174 MHz frequency band.

3.2.1.5.1 Operating service conditions.- Each antenna shall meet the basic and required characteristics over the range of operating service conditions specified below:

(a)	Temperature	-55° C to +70° C
(b)	Relative humidity	0 percent to 100 percent including seacoast salt spray environment
(c)	Wind and ice loading	Up to 85 knots with up to 1/2 inch of radial ice
(d)	Precipitation	Up to 7 inches of rainfall per hour

3.2.1.5.2 Basic characteristics.- The antenna assembly shall be a quarter-wave vhf whip antenna, omnidirectional, and vertically polarized with a grounded radiator element for lightning protection. Each antenna shall be terminated at its base with a Type N female coaxial connector in accordance with MIL-STD-242F, part I, section 302. A mating coaxial plug shall be provided for each connector.

3.2.1.5.3 Performance requirements.- Each antenna shall meet the characteristics that are listed in table II. Performance requirements shall be met throughout the frequency range of 162 MHz to 174 MHz.

3.2.1.5.4 Transmitter antenna mounting.- The transmitter antenna mounting assembly shall be designed for side mounting on a galvanized support pipe. All hardware required for mounting and securing the antenna shall be provided for use with either a 1-1/4 inch or 2-1/2 inch pipe. The assembly shall be provided with seals to prevent any moisture from entering the coaxial cable or the cable termination.

3.2.1.5.5 Receiver antenna mounting.- The receiver antenna shall be designed to be mounted on the side of the outdoor receiver cabinet enclosure. The mounting assembly shall be provided with insulating fastenings to the receiver cabinet in at least two places. The coaxial cable connection shall be provided with moisture-proof seal to prevent moisture from entering the cable.

3.2.1.6 FM receiver.- A narrow-band, double-conversion, crystal-controlled, frequency modulated receiver that will be installed at the visual aid facility shall be capable of receiving the signal transmitted from the transmitter in the air traffic control tower area, and shall demodulate the received signal and provide CMOS logic compatible serial data code signals into a high input impedance decoder unit.

3.2.1.6.1 Receiver performance requirements.- Each fm receiver shall meet the performance characteristics that are listed in table III.

3.2.1.6.2 Receiver power supply.- An integral direct current power supply shall be provided with the fm receiver. The power supply shall operate from a 120 ±18 V ac, 60 Hz power source.

Table II. Antenna Performance Requirements

Parameter		Requirements
(a)	Polarization	vertical
(b)	Elevation beam width half-power points (min)	50°
(c)	Azimuthal radiation pattern (departure from true circle at peak)	omnidirectional ±1 dB
(d)	Elevation radiation pattern peak of main beam (ref 0° is horizon in elevation angle)	0° ± 10°
(e)	Antenna voltage standing-wave ratio (vswr) (max)	2.00:1
(f)	Radio frequency (rf) power gain minimum (reference to isotropic radiator)	0 dB
(g)	Terminal impedance, ohms, nominal	50
(h)	RF power rating, watts (min) (carrier power modulated 100 percent with 1 kHz tone)	25

3.2.1.6.3 Receiver attack time.- The receiver attack time shall not exceed 30 milliseconds.

3.2.1.6.4 Hum and noise ratio.- The hum and noise ratio unsquelched shall be 60 dB.

3.2.1.7 Decoder.- The decoder shall receive demodulated signals from the fm receiver and decode only signals that correspond to a particular visual aid system. The decoder shall provide signals to an interface unit meeting the requirements of FAA-E-2663 for each of up to eight status conditions. The decoder at the emergency engine generator facility shall provide contact closure or opening for 24 V dc signals which shall turn the engine generators on or off.

3.2.1.7.1 Decoder programing.- Circuitry shall be provided for programing the decoder to process the serial data code signal corresponding to a specific facility and function command codes. It shall be possible to reprogram the decoder for a different facility code signal without unsoldering wires or replacing components.

Table III. Receiver Performance Requirements

Parameter	Requirement
(a) Spurious and image rejection	More than 60 dB
(b) Adjacent channel selectivity and desensitization	More than 70 dB at 25 kHz
(c) Frequency stability	±0.0025% between -55° C and +70° C
(d) Spurious radiation	Meet the NTIA requirement of -80 dBW and Federal Communication Commission (FCC) rules pertaining to radio frequency devices, part 15, subpart C, section 15.63
(e) Output level	CMOS logic compatible serial data code
(f) Output impedance	600 ohms max (unbalanced)
(g) Frequency response	±3 dB from 200 Hz to 3000 Hz
(h) Operating voltage	12 V dc ±10%
(i) Electronic Industries Association (EIA) Signal and Noise Distortion (SINAD) intermodulation	-80 dB
(j) Electronic Industries Association (EIA) modulation acceptance	±6.5 kHz min
(k) Sensitivity 50 ohm rf input impedance	Less than 0.50 μV for 20 dB quieting, less than 0.35 μV for EIA SINAD
(m) Intermodulation spurious response attenuation	50 dB min

3.2.1.7.2 Decoder signals.- The demodulated CMOS logic compatible serial data signals from the fm receiver shall be compatible with the logic circuitry used in the decoder. The serial data signals shall be decoded to provide contact closure for 24 V dc signals to an interface unit meeting the requirements of FAA-E-2663. The 24 V dc power is provided by the interface unit. The contact closure (24 V dc) decoder output signals shall perform the functions described in 3.1.2.

3.2.1.7.3 Decoder power supply.- An integral power supply shall be provided in the decoder assembly which will provide the decoder power requirements. The power supply shall operate from a 120 ±18 V ac, 60 Hz power source.

3.2.2 Physical characteristics

3.2.2.1 Switch assembly cabinet.- The switch assembly cabinet shall provide for mounting five switch assembly panels. The switch assembly cabinet shall be no larger than 9-1/2 by 9 by 8 inches deep. The switch assembly cabinet shall be fabricated from 14 gage steel. Its surfaces shall be finished in accordance with 3.4.3.6. The switch assembly cabinet shall be provided with blank panels to cover unused spaces.

3.2.2.1.1 Blank panels.- Blank panels shall be 1-1/2 by 9 inches long as indicated in figure 2. Four blank panels shall be provided with each switch assembly cabinet.

3.2.2.1.2 Motherboard.- The motherboard shall be 7-1/2 by 8-1/2 inches long as indicated in figure 4. It shall have five connectors that mate with plugs on the rigid frames supporting the encoder units (3.2.1.2.3).

3.2.2.2 Switch assembly panel.- The switch assembly panel shall be designed using the modular construction concept. It shall have a mounting capacity of nine lighted pushbutton switches. Each switch shall be provided with an approximately 1/2-inch square lighted pushbutton, with a projected color filter and an identification legend in black letters. The color of the filters shall be in accordance with table IV. The switch shall be rated for 1 million operations. The panel shall be provided with a rigid frame that holds the encoder unit card. A connector and a guide pin shall be attached to the rigid frame for mating with a receptacle on the motherboard. Two holes shall be drilled in the panel to allow mounting into the switch assembly cabinet (see figure 2). The switch assembly panel shall be made of 0.125 inch thick 5052-H32/H34 anodized aluminum. Surfaces of the panel shall be given a protective finish in accordance with 3.4.3.6.

3.2.2.2.1 Encoder unit card.- The encoder unit card shall be no larger than 7 by 3-1/2 inches. Lamp test circuitry shall be installed on the encoder unit card. The encoder unit card shall be attached to a rigid frame.

3.2.2.3 Encoder interface unit.- The encoder interface unit, including the power supply, shall be designed to mount onto a standard 19-inch relay rack conforming to FAA-E-163. The installation shall be in accordance with FAA-G-2100c, paragraph 3.3.3.3.

3.2.2.4 The frequency modulated transmitter assembly.- The fm transmitter assembly shall be designed to mount onto a standard 19-inch relay rack conforming to FAA-E-163. The installation shall be in accordance with FAA-G-2100c, paragraph 3.3.3.3.

3.2.2.5 Frequency modulated receiver.- The fm receiver shall be provided mounted in a dust-tight, airtight, and waterproof National Electrical Manufacturers Association (NEMA-12) cabinet. The cabinet shall be equipped with a quarter-wave whip antenna for the assigned frequency and two 1-inch conduit hubs on the bottom for power and signal lines.

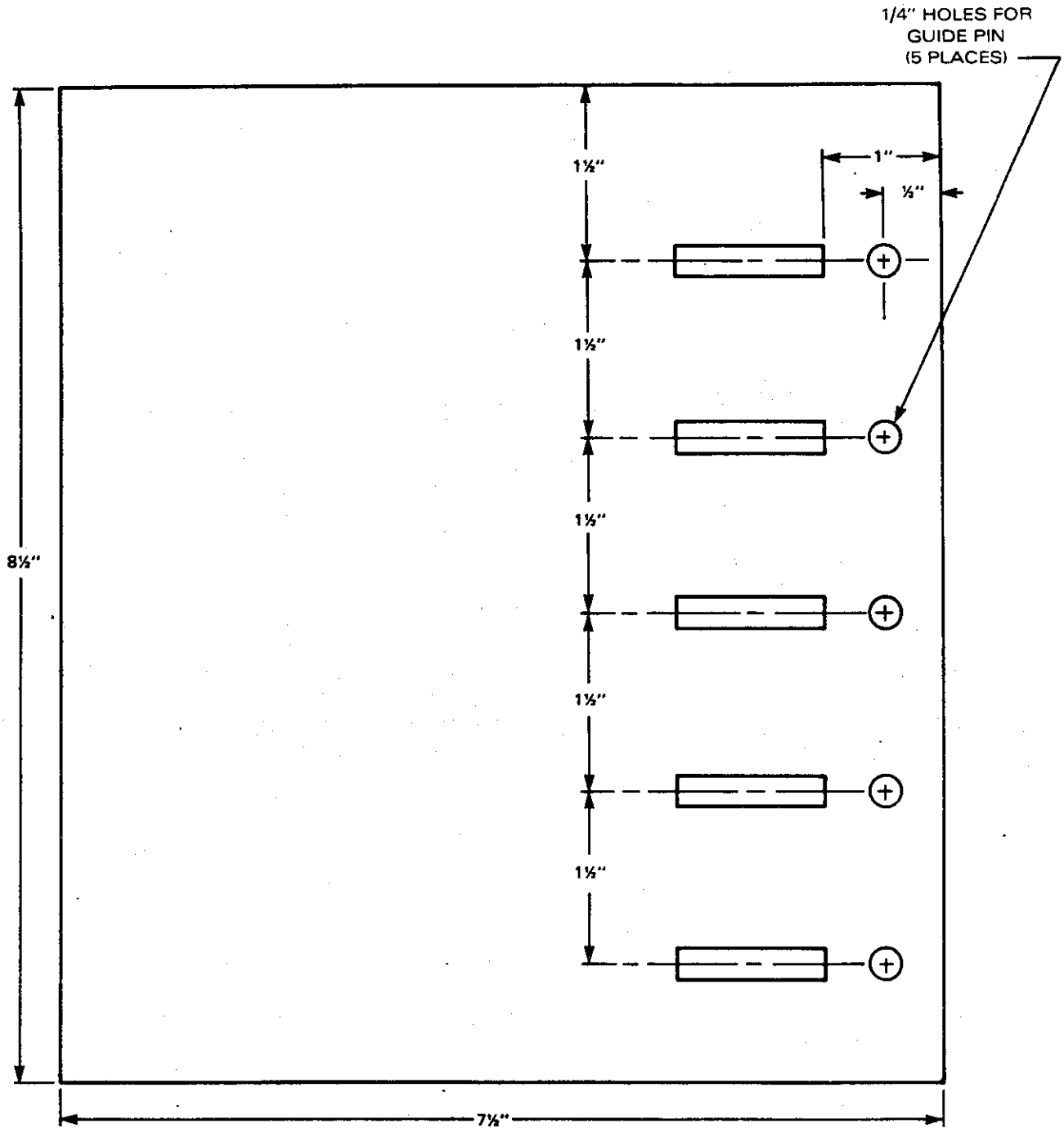

Figure 4. Motherboard

Table IV. Identification of Color Filters

Indicator Lights		Filter Color
Facility switches	33R, 33R, 33L	White
Function command switches	MALS1, MALS2, MALS3 ODALS1, ODALS2, ODALS3	Green
ON switches	RAIL ON, VASI ON	Green
OFF switches	MALS OFF, RAIL OFF, ODALS OFF, VASI OFF	Red
G/G enable and A/G enable switches	G/G ON, A/G ON	Amber

3.2.2.6 Decoder.- The decoder shall be provided, mounted in a dust-tight, raintight, and waterproof NEMA-12 cabinet that is equipped with two 1-inch conduit hubs on the bottom for power and signal lines.

3.2.2.7 Cabinet.- The receiver cabinet and decoder cabinets shall be outdoor, rainproof, dust-tight, nonventilated enclosures. The cabinet shall be rigidly constructed and shall not distort or bend under normal methods of shipping, handling, and installation. The cabinet shall be stainless steel or sheet aluminum. Stainless steel shall be in accordance with 3.4.2.3. Aluminum enclosures shall be anodized in accordance with MIL-A-8625. The cabinet shall be of sufficient size to accommodate all of the necessary components and wiring and provide adequate clearance for field installation and maintenance. It shall have mounting means external to the cabinet cavity and provision for locking. Space shall be provided in the cabinet for all external cable connections. Terminal blocks shall be located near the cable entrance to permit terminations of all external power and control wires feeding into the cabinet. Mounting lugs or bolts shall be provided on the back of the cabinet for mounting the cabinet vertically. Internal or external mounting bolts shall not protrude through the cabinet.

3.2.2.7.1 Door gaskets.- Door gaskets shall be either continuous or strip gaskets. If strip gaskets are used; (a) the total number of strips used shall not exceed four; (b) the vertical and horizontal runs shall be continuous except where the vertical strips meet the horizontal strips; (c) the horizontal strips shall overlap the vertical strip; and (d) the vertical strip shall be butted tightly against the horizontal strip. Gaskets shall be synthetic rubber or neoprene or a composition gasket utilizing these two materials and shall be resistant to deterioration such as cracking, hardening, or softening under the environmental conditions the equipment will operate in.

3.2.2.7.2 Cabinet door.- The cabinet door shall open from the right side of the cabinet. The door hinge may be internally or externally mounted and shall be corrosion resistant. A door-stop shall be provided for locking the door in a 120-degree open position. No electrical components or cables shall be attached to the door.

3.2.2.7.3 Locking.- The cabinet door shall be provided with a mechanism for locking the door closed. The holes for the padlock shall be aligned such that a 3/8-inch diameter rod can be passed horizontally through the holes when the door is in a locked position.

3.2.2.7.4 Wiring diagram plate.- A wiring diagram plate shall be provided which matches the wiring diagram figure provided in the instruction book manuscript in accordance with FAA-D-2494/1, paragraph 1-3.9.2.10. The plate shall be mounted on the instruction book holder. The plate shall be Type A, F, or H and the color style shall be I or IV in accordance with MIL-P-15024.

3.2.3 Environmental conditions.- The equipment shall be designed for continuous operation under the following environmental conditions.

3.2.3.1 Indoor equipment.- The equipment to be installed in the air traffic control towers shall operate in the ambient conditions specified as Environment I in table II of FAA-G-2100c.

3.2.3.2 Outdoor equipment.- The equipments to be installed as part of the outdoor unattended facilities shall operate in the following environments:

3.2.3.2.1 Temperature.- An ambient temperature range from -55° C to +70° C.

3.2.3.2.2 Altitude.- Sea level to 10,000 feet mean sea level (msl).

3.2.3.2.3 Humidity.- Up to 95 percent relative humidity from sea level to 10,000 feet (msl) and +70° C ambient temperature.

3.2.3.2.4 Sand and dust.- Exposure to wind-blown sand and dust particles as may be encountered in arid regions.

3.2.3.2.5 Salt spray.- Exposure to salt-laden atmosphere.

3.2.3.2.6 Rain.- Exposure to wind-blown rain.

3.2.3.2.7 Solar radiation (sunshine).- Exposure to sunshine with ambient temperature as stated in 3.2.3.2.1.

3.3 System requirements.- The remote (radio) control system shall consist of a switch assembly cabinet, a switch assembly panel, an encoder interface unit, a transmitter, a receiver, and a decoder. These units shall be designed using modular construction concepts for ease of maintenance, shall employ printed wiring boards where practical, have interchangeable parts between like systems, have readily accessible test points for all major signals, and have lightning and transient protection. It shall be possible to make system measurements using conventional test equipment. The alignment procedures shall be straightforward and easy to accomplish. Equipment design shall comply with the National Electrical Code, NFPA No. 70.

3.3.1 Power loss.- The interruption of primary power, either at the facility site or the Air Traffic Control Tower (ATCT), for short or long durations, shall not cause the system to restart in an undefined state upon restoration of power. All commands shall be permanently stored and shall not require intervention or reactivation from the operator upon restoration of power. Solenoid hold devices shall not be employed.

3.3.2 Modular construction.- All electronic, electrical, and mechanical components shall be designed and constructed to minimize skill, experience, and time necessary to disassemble, assemble, and maintain them. All electronic circuits shall be designed using plug-in printed wiring boards except where high voltage or high power devices are utilized. Similar functions shall be performed using identical modules wherever practical, and preference shall be given to designs which afford component replaceability.

3.3.3 Interchangeability.- All like parts of each system shall be interchangeable between systems, and identical parts within each system shall be interchangeable. Identical parts shall be identified with identical part numbers and unlike parts shall not have the same part number. Interchangeability shall be in accordance with MIL-STD-454, requirement 7.

3.3.4 Transient suppression.- The equipment shall be designed to withstand repeated transient increases in the 120 V ac (rms) line voltage superimposed on the ac power line voltage waveform and reaching a peak voltage which is 120 percent of the peak value of ac line voltage for as long as 50 milliseconds. The indoor equipment shall be designed to withstand repeated ac power line transients applied at the equipment power input and characterized as an 8 by 20 microseconds current surge of 3,000 amperes with the subsequent power-follow current and voltage surge of 6 kV, 1.2 by 50 microseconds waveform, as defined in ANSI Standard C62.1. In addition, the outdoor equipment shall be designed to withstand repeated transients applied at the power and control signal inputs, at the output lines, and characterized as a 10 by 20 microseconds current surge of 10,000 amperes with the subsequent power-follow current and voltage surge of 10 kV/microsecond minimum. The equipment shall restart automatically if an interruption or a shutdown is experienced due to either type of transient. Equipment operational functions shall be unimpaired by the above transients when each type of transient is imposed a minimum of 10 times each to the input terminals. Lightning protectors shall be provided for all power and control lines at their first point of entry into the equipment, and at their exit from the equipment. The return for the lightning protectors shall be connected to earth ground via a separate dedicated conductor not less than a No. 6 American Wire Gage (AWG).

3.3.5 Test points and controls.- Test points shall be provided on all signals that are required to be monitored during checkout, alignment calibration, or during preventive maintenance procedures. Test points shall not be located in compartments with voltage points of 500 volts or more, and all test points shall be located so as to preclude accidental shock to personnel engaged in normal operating or maintenance activities. The removal of components, modules, or circuit cards shall not be required to gain access to test points or adjustments. Test points, controls, and indicators mounted on printed wiring boards shall be accessible from the front of the circuit cage assembly without the use of extender boards. All test points and controls shall be brought out and

terminated in a central location within the equipment cabinet. The termination shall be in a female connector to allow easy connection to an external remote maintenance monitoring system and to be used during preventive maintenance procedures.

3.3.6 Extender boards.- Extender boards or cables shall be provided for all printed wiring boards that are used as plug-in subassemblies. The use of extender boards or cables shall be limited to corrective maintenance only and shall not be required for calibration, adjustment, or preventive maintenance activity.

3.3.7 Derating of electronic parts.- Derating of electronic parts and materials shall be in accordance with MIL-STD-454, requirement 18.

3.4 Equipment or system components.- Parts, materials, and processes selected for use in this equipment shall be in conformity with the specific requirements herein.

3.4.1 Parts.- Parts shall be as specified herein.

3.4.1.1 AC power connections.- AC line control circuits, parts, and protective devices shall meet the requirements of FAA-G-2100c, paragraph 3.3.2.1 and subparagraphs.

3.4.1.2 Discrete components.- Discrete components shall be in accordance with the following requirements of MIL-STD-454:

(a)	Capacitors	Requirement 2
(b)	Connectors	Requirement 10
(c)	Controls	Requirement 28
(d)	Indicator lights	Requirement 50
(e)	Relays and contactors	Requirement 57
(f)	Resistors	Requirement 33
(g)	Switches	Requirement 58
(h)	Transformers, inductors	Requirement 14

3.4.1.3 Fuses.- All equipments shall be provided with adequate fuses for protection against overloads or short circuits within the equipments. Fuses and fuseholders shall be in accordance with MIL-STD-454, requirement 39, with limitations and additional requirements specified below.

(a) Fuseholders shall be extractor, indicating type and shall be mounted on the front panels.

(b) All fuse positions shall be marked with the rated current capacity of the fuse to be employed therein. The marking shall be on the insertion side, so as to be visible when replacing fuses.

(c) Fuses shall be designed for quick removal and replacement.

3.4.1.4 Microelectronic devices.- Only Class B product assurance level devices in accordance with MIL-M-38510 shall be used. All microelectronic devices shall be mounted by soldering techniques in accordance with MIL-STD-454, requirement 5. The packaging style for microelectronic devices shall be selected from table V. All devices shall be hermetically sealed; plastic encapsulation shall not be used.

3.4.1.5 Semiconductor devices.- Semiconductor devices, except integrated circuits, shall be as specified in MIL-STD-454, requirement 30.

3.4.1.6 Threaded parts and fasteners.- Threaded parts and fasteners shall conform to the requirements of FAA-G-2100c, paragraph 3.5.10.

3.4.1.7 Nameplates.- Each equipment furnished shall have a nameplate in accordance with FAA-G-2100c, paragraph 3.10.

3.4.1.8 Other parts.- Parts not otherwise specified shall be in accordance with FAA-G-2100c. If parts are not covered by FAA-G-2100c, they shall be in accordance with established industry standards.

3.4.2 Materials.- Materials shall be as specified herein. Materials that are not specified herein, shall comply with FAA-G-2100c. Any materials, for which no specification is provided, shall be of commercial quality and suitable for the purpose.

3.4.2.1 Printed wiring boards (pwb).- All electronic components, except power devices, shall be mounted on printed wiring boards. Printed wiring boards shall be in accordance with MIL-STD-275 and MIL-P-55110, except as modified by FAA-G-2100c, paragraph 3.5.23. Conformal coating of pwb's is required and shall be type AR per MIL-I-46058.

3.4.2.2 Adhesives.- Adhesives, if used, shall be in accordance with MIL-STD-454, requirement 23.

3.4.2.3 Stainless steel.- At the option of the contractor, stainless steel may be used for any purpose for which another material is not definitely specified elsewhere herein or elsewhere in the contract specifications, provided that all stainless steels shall be of the following types:

American Iron and Steel Institute

Type Numbers

301	305	316L
302	308	317
302B	309	321
303	310	322
304	314	322A
304L	316	347

Table V. Packaging Reference Selection

Packaging Preference Category	Selection Criteria
1 (Dual inline)	Shall be used wherever required functions can be accomplished in accordance with good engineering practices. No approval is required for use of this category.
2 (Modified TO-5)	Shall be used only in those cases where selection of a suitable device from category 1 is not possible. Selection from category 2 does not require prior approval of the Contracting Officer; however, the contractor shall notify the Government in writing of the selection.
3 (Flat pack)	Requires written Government approval before adoption for use in equipment. In requesting such approval, the contractor must present engineering proof, satisfactory to the Government, that selection from category 3, rather than from category 1 and category 2, is necessary and will be to the advantage of the Government.

3.4.3 Processes.- All processes used in the assembly or manufacture of equipments for this system shall be suitable for the intended purposes of the equipments.

3.4.3.1 Brazing.- Brazing shall be in accordance with MIL-STD-454, requirement 59, except that electrical connections shall not be brazed. Paragraph 3.3 of requirement 59 is not applicable.

3.4.3.2 Soldering.- Soldering shall be in accordance with MIL-STD-454, requirement 5.

3.4.3.3 Lugs connected to screw terminals.- Where wires are connected to solderless or solder lugs which are clamped under screw terminals so as to be removable by loosening or removing the screws, not more than one wire shall be attached to each lug, so that each wire can be removed individually from the screw terminals. Not more than three lugs shall be attached to each screw terminal.

3.4.3.4 Cable connector wiring.- Not more than one wire shall be attached to each contact of each cable connector.

3.4.3.5 Splices.- Wires and cables shall not be spliced.

3.4.3.6 Finishes.- Finishes shall be in accordance with FAA-G-2100c, paragraph 3.7.7.

3.4.3.7 Wire, cable, and wiring practices.- Wire, cable, and wiring practices shall be as specified in FAA-G-2100c, paragraph 3.5.38.

3.4.3.8 Workmanship.- Workmanship shall be in accordance with MIL-STD-454, requirement 9.

3.4.3.9 Terminals.- Terminals, boards, and strips shall be in accordance with FAA-G-2100c, paragraph 3.5.3.4. Terminals shall be of the enclosed base type with pressure-type terminal connectors.

3.5 Documentation

3.5.1 Instruction book manuscript.- Instruction book manuscripts shall be prepared as required herein. They shall cover the items of equipment being furnished under the contract.

3.5.1.1 Draft manuscript.- A draft manuscript of the instruction books covering the entire system shall be prepared and submitted in accordance with the requirements of FAA-D-2494/1.

3.5.1.2 Final manuscript.- A final manuscript shall be provided as camera-ready copy as required by FAA-D-2494/2.

3.5.2 Instruction books.- The Government will reproduce and prepare instruction books from the manuscript and furnish copies to the contractor for shipment with the equipment. One instruction book shall be included with each unit of equipment.

3.6 Reliability

3.6.1 Reliability design criteria.- The equipment listed in table VI shall meet the listed reliability requirements:

3.6.2 Reliability program

3.6.2.1 Organization.- The head of the reliability management organization shall have the necessary authority, resources, and access to higher management to enable him to implement and enforce the requirements specified herein in accordance with MIL-STD-785.

3.6.2.2 Subcontractor and supplier reliability program control.- Subcontractors and suppliers shall be bound by the same reliability requirements as the contractor. Any deviations shall be presented to the FAA program office for review and approval.

3.6.2.3 Reliability analyses.- Preliminary reliability predictions and failure mode and effects analyses shall be prepared and submitted at the preliminary design review for evaluation and approval. Updated and final reliability analyses shall be submitted as the design changes. Reliability predictions shall be prepared and performed in accordance with MIL-HDBK-217.

Table VI. Equipment Reliability Requirements

	Equipment	Upper Test Mean Time Before Failure (MTBF) (hours)	Lower Test Mean Time Before Failure (MTBF) (hours)
(a)	Switch assembly panels, switch assembly cabinet, encoder, interface unit, and power supply, as a subsystem.	20,000	10,000
(b)	Decoder	20,000	10,000
(c)	FM transmitter	10,000	5,000
(d)	FM receiver	10,000	5,000

3.6.2.4 Parts control task.- The parts reliability control program shall conform to the requirements for parts reliability (see 3.4.1 and 3.4.2). All reliability requirements placed upon the contractor are equally applicable to subcontractors/vendors and the reliability manager shall be responsible for assuring compliance, and shall be responsible for assuring that the appropriate requirements are placed in subcontractor specifications.

3.7 Maintainability

3.7.1 Maintainability design criteria.- The equipment listed in table VII shall meet the listed maintainability requirements:

3.7.2 Maintainability program

3.7.2.1 Maintainability program management.- The contractor shall have one clearly identified organizational element which shall be responsible for planning, implementing, controlling, and reporting all maintainability tasks required by this specification in accordance with MIL-STD-470.

3.7.2.2 Organization.- The head of the maintainability management organization shall have the necessary authority, resources, and access to higher management to enable him to implement and enforce the requirements specified herein. The maintainability management organization may be part of the reliability management organization.

3.7.2.3 Maintainability predictions.- The contractor shall predict maintainability values for the system/equipment. The prediction technique specified herein shall be used. The prediction technique shall estimate quantitatively the maintainability system/equipment parameter values for the planned design configuration. The quantitative estimates shall be used to judge the adequacy of the proposed design to meet the maintainability quantitative requirements and identify design features requiring corrective action.

Table VII. Equipment Maintainability Requirements

Equipment	Mean Time to Repair (MTTR)	Maximum Repair Time
(a) Switch assembly panels, switch assembly cabinet, encoder, interface unit, and power supply, as a subsystem	15 min	30 min
(b) Decoder	15 min	30 min
(c) FM transmitter	15 min	30 min
(d) FM receiver	15 min	30 min

3.7.2.3.1 Early design predictions.- During the early design and development stages, prediction of mean corrective maintenance time shall be prepared and performed in accordance with procedure III of MIL-HDBK-472. The prediction shall be submitted 15 days prior to preliminary design review (PDR).

3.7.2.3.2 Final design predictions.- During the final design stages of development, predictions of mean corrective maintenance time shall be in accordance with procedure II of MIL-HDBK-472. The prediction shall be submitted 15 days prior to critical design review (CDR).

3.8 Site spare parts.- Each unit of equipment (see 3.1.1) shall include one spare printed circuit board assembly of each type used with each equipment (complete with all components, tested and operable) and one spare module of each type used in each unit of equipment.

3.8.1 Module.- A module is defined as being two or more basic parts that form a functional assembly that is a portion of a larger assembly or unit. The module is easily removed intact and replaced by plug-in, unsoldering, quick-disconnect, fastener, or equivalent means. It may or may not contain printed circuitry and it may contain active or passive devices.

3.8.2 Printed circuit board assembly.- A card shall be defined as a printed circuit board and all mounted components that have been electrically connected and tested.

3.9 Configuration management.- The contractor shall implement a configuration management program in accordance with FAA-STD-021. As a minimum, the contractor shall submit within 30 days after receipt of contract, a configuration management plan for review and approval by the Government.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- The contractor shall establish and maintain a quality control program in accordance with FAA-STD-013. Unless otherwise specified in this specification or in the contract, all tests and inspections to determine compliance with the requirements of the contract specifications shall be made by the contractor or his subcontractor and shall be subject to Government inspection. The term "Government inspection" as used in this specification, means that an FAA representative will witness the contractor's or subcontractor's testing and inspections, and will carry out such visual and other inspections as necessary to assure compliance with this specification.

4.1.1 Data certification.- Prior to the system inspection, the contractor shall submit to the FAA representative certified data covering shipment of each item from the supplier's plant to that of the prime contractor. Each document shall carry the vendor's certification that each item furnished meets the requirements of this specification. The certification shall be traceable to manufacturer's quantitative test data pertaining to the specific subsystem or component. Vendor certification does not constitute FAA acceptance of any part or unit of equipment provided under this specification or release that part or unit from acceptance testing by the contractor.

4.1.2 List of tests.- The contractor shall provide a list of tests that will be conducted to prove compliance with the performance requirements of the specification. This list shall identify all detailed tests to be performed and shall be submitted to the Government for review and approval. All test procedures shall reference the specific specification paragraph number being demonstrated. The list of tests shall include the design qualification tests and the production unit tests.

4.2 Notification of readiness for inspection.- After receipt of approval of test procedures (see 4.1) and test data forms (FAA-STD-013), the contractor shall notify the Contracting Officer in writing that he is ready for Government inspection. Such notification shall be given in time to reach the Contracting Officer not less than 5 work days before the contractor desires inspection to start. All testing described herein shall be performed at the contractor's expense at the contractor's facility or at an FAA approved location or independent testing laboratory.

4.3 Test methods.- Testing of the system shall be performed as indicated in the following subparagraphs.

4.3.1 Design qualification test.- The first unit of production is designated as the production model. The production model shall be subjected to the tests specified in table VIII. The production model after passing the design qualification tests, shall be a deliverable item under the contract.

4.3.2 Production unit test.- Testing of the production units shall start after acceptance of the production model. Tests on production units shall consist of visual inspection in accordance with 4.4.1, and the system test in accordance with 4.4.2.

Table VIII. Qualification Tests

Test \ Equipment	Switch Assembly Panel	Switch Assembly Cabinet	Encoder Interface Unit	FM Transmitter	FM Receiver	Antenna	Decoder
Visual (4.4.1)	X	X	X	X	X	X	X
System (4.4.2)	X	X	X	X	X	X	X
Temperature (4.4.3.1)	X	X	X	X	X	X	X
Humidity (4.4.3.2)	X	X	X	X	X	X	X
Altitude (4.4.3.3)	X	X	X	X	X	X	X
Solar radiation (4.4.3.4)					X	X	X
Rain (4.4.3.5)					X	X	X
Salt spray (4.4.3.6)					X	X	X
Sand and dust (4.4.3.7)					X	X	X
Transient suppression (4.4.4)		X	X	X	X		X
Interference (4.4.5)	X	X	X	X	X		X
150-hours (4.4.6)	X	X	X	X	X	X	X
Transmitter (4.4.7)				X			
Receiver (4.4.8)					X		
Antenna (4.4.9)						X	

4.3.3 Operational testing.- Operational testing shall be accomplished using a complete radio control system as shown in figure 5.

4.4 Tests

4.4.1 Visual inspection.- The systems shall be visually inspected for workmanship, safety, fabrication, finish, painting, and compliance of selected parts.

4.4.2 System and spare parts test.- Each deliverable system or part of a system shall be connected together in accordance with 4.3.3 and tested as a system for a minimum of 2 hours. Each functional control, mode control, and status indicator shall be exercised to demonstrate full compliance with the specification. Any erratic switching, loss of control, or operation outside of the prescribed limits shall be cause for rejection. Each function shall be exercised at least twice during the test period.

4.4.3 Environmental tests.- Environmental tests shall be as specified herein.

4.4.3.1 Temperature.- High temperature testing in accordance with MIL-STD-810C, procedure II, method 501.1, and low temperature testing in accordance with MIL-STD-810C, procedure I, method 502.1, shall be performed to demonstrate compliance with the temperature requirements of 3.2.3.2.1.

4.4.3.2 Humidity.- Humidity testing in accordance with MIL-STD-810C, procedure I, method 507.1, shall be performed to demonstrate compliance with the humidity requirements of 3.2.3.2.3.

4.4.3.3 Altitude.- Altitude testing in accordance with MIL-STD-810C, procedure I, method 504.1, shall be performed to demonstrate compliance with the altitude requirements of 3.2.3.2.2

4.4.3.4 Solar radiation (sunshine).- Solar radiation testing in accordance with MIL-STD-810C, procedure II, method 505.1, shall be performed to demonstrate compliance with the solar radiation requirements of 3.2.3.2.7. The equipment shall be operated for 1 hour during the third cycle when the test item has reached its peak temperature.

4.4.3.5 Rain.- Rain testing in accordance with MIL-STD-810C, procedure I, method 506.1, shall be performed to demonstrate compliance with the rain requirements of 3.2.3.2.6. The equipment shall be operated during the last 10 minutes of the 30-minutes rain test.

4.4.3.6 Salt spray.- Salt spray testing in accordance with MIL-STD-810C, procedure I, method 509.1, for not less than 168 hours, shall be performed to demonstrate compliance with the salt spray requirements of 3.2.3.2.5. Salt buildup as a result of the test may be removed with tap water.

4.4.3.7 Sand and dust.- Sand and dust testing in accordance with MIL-STD-810C, procedure I, method 510.1, shall be performed to demonstrate compliance with the sand and dust exposure requirements of 3.2.3.2.4. Delete steps 2 and 3 in procedure I and rotate the equipment 120° twice. Air velocity shall be 2,500 ±500 feet per minute.

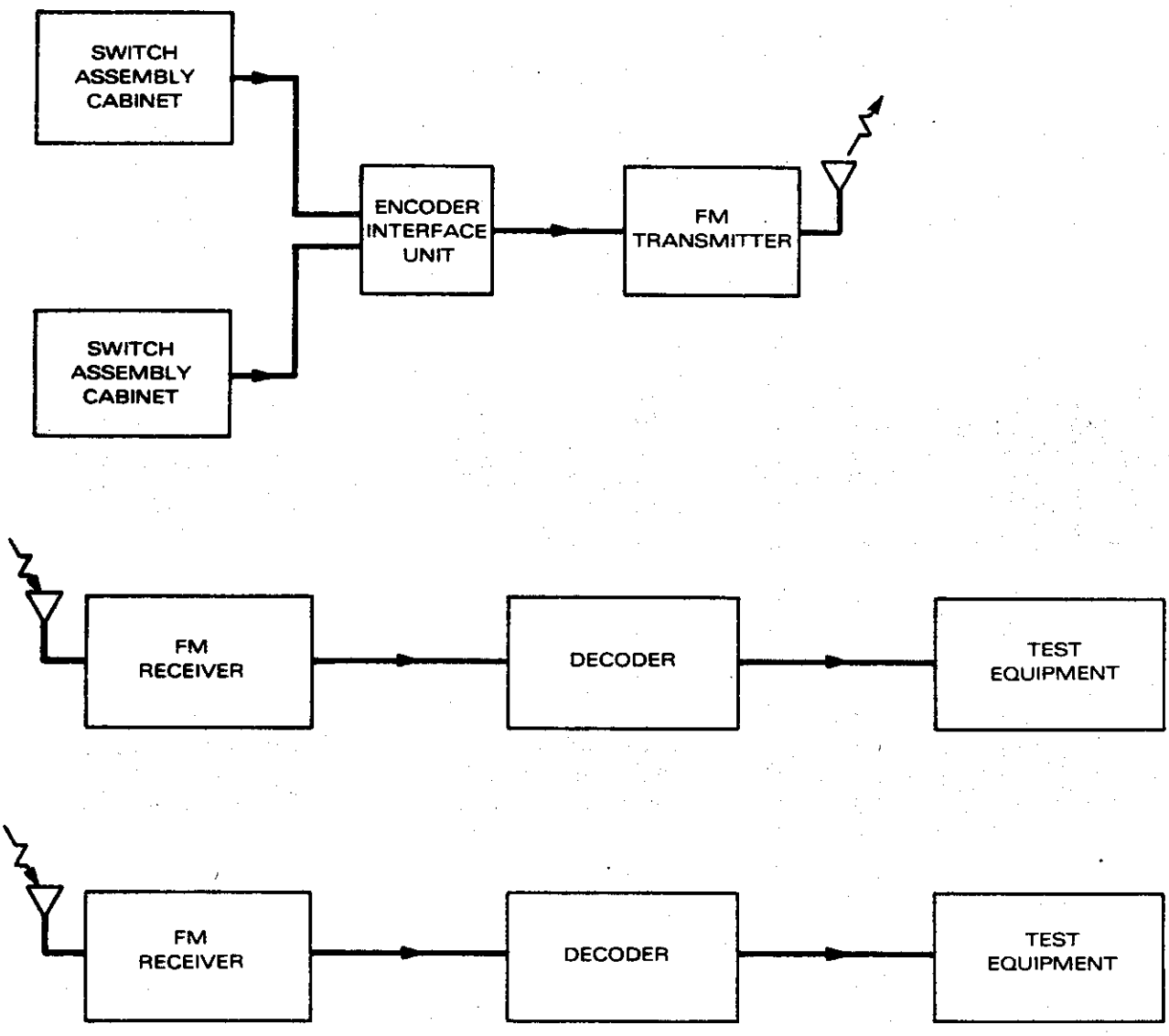

Figure 5. Operational Test Setup

4.4.4 Transient suppression test.- The production model shall be tested for transient suppression comforming with the requirements specified in 3.3.4.

4.4.4.1 Test procedure.- A surge generator shall be set to superimpose specified (see table IX) transient control levels on the energized ac power line and control signals output line of the equipment. These levels shall be verified by open-circuit and short-circuit tests prior to testing the equipment. The surge generator, with a preset transient-control level, shall then be connected to the input power line and output line of the energized equipment. A minimum of 10 test surges for each transient control level shall be superimposed on the power and output lines of the energized equipment. Test surges shall be applied between each input terminal and ground and each output terminal and ground, as well as between the input terminals of a circuit pair and the output terminals of a circuit pair. At the conclusion of the test, the equipment shall be tested to verify compliance with the performance requirements of 3.2.1. The test shall be done with the system operating and connected in accordance with 4.3.3.

4.4.5 Interference test.- Electromagnetic emissions levels on the power leads, control leads, signal leads, and interconnecting cables between parts, shall not exceed the limits for CE01 and CE03, as defined in MIL-STD-461. Measurement of the emissions levels shall be in accordance with test methods CE01 and CE03 of MIL-STD-462. Radiated susceptibility limits over the frequency ranges of 30 Hz to 30 kHz and 30 kHz to 200 MHz shall be in accordance with limits for RS01 and RS03 of MIL-STD-461, respectively. Measurement of the radiated susceptibility shall be in accordance with test methods RS01 and RS03 of MIL-STD-462.

4.4.6 150-hours test.- The system shall be connected together in accordance with 4.3.3 and tested as a system for a minimum of 150 continuous hours. Each functional control and status indicator shall be exercised to demonstrate full compliance with the specification. Any erratic switching, loss of control, or operation outside of the prescribed limits shall be cause for rejection. Each function shall be exercised at least once during each hour of the test period.

Table IX. Transient Control Level

Transient Control Level Number	Open-Circuit Voltage Level (Volts)	Short-Circuit Current Level (Amperes)
1	150	50
2	170	60
3	6,000	3,000
4	10,000	10,000

4.4.7 Transmitter tests.- The following fm transmitter parameters shall be tested in accordance with EIA standard RS-152-B:

RS-152-B Section	Parameter	FAA-E-2723 Paragraph
3	Carrier power output	(3.2.1.4)
4	Conducted spurious emissions	(3.2.1.4.1)
5	Radiated spurious emissions	(3.2.1.4.1)
6	Audio frequency harmonic distortion	(3.2.1.4.6)
7	Audio frequency response	(3.2.1.4.7)
8	FM hum and noise level	(3.2.1.4.5)
9	Modulation limiting	(3.2.1.4.8)
10	Carrier frequency stability	(3.2.1.4.2)
18	Transmitter attack time	(3.2.1.4.10)

4.4.8 Receiver test.- The following fm receiver parameters shall be tested in accordance with EIA Standard RS-204-B:

RS-204-B Section	Parameter	FAA-E-2723 Paragraph
8	Receiver attack time	(3.2.1.6.3)
11	Adjacent channel selectivity	(3.2.1.6.1)
12	Spurious response attenuation	(3.2.1.6.1)
15	Audio frequency response	(3.2.1.6.1)
16	Hum and noise ratio	(3.2.1.6.4)
17	Power supply voltage range	(3.2.1.6.2)
24	Audio sensitivity	(3.2.1.6.1)
25	Undesired conducted spurious output signals	(3.2.1.6.1)

4.4.9 Antenna test.- One of each type of antenna assembly being furnished shall be tested to demonstrate all of the main and required characteristics stated in 3.2.1.4 and associated subparagraphs herein. Performance requirements shall be demonstrated under the environmental conditions specified in 3.2.1.5.1.

4.5 Test instruments.- The manufacturer or the testing laboratory performing preproduction and production tests shall provide adequate instrumentation for these tests. All instruments shall have calibration labels indicating that the instruments have been calibrated by a reliable laboratory in accordance with FAA-STD-013, paragraph 2.4. Indicating instruments, voltmeters, and ammeters shall be of the 0.5 percent classification or better. Alternating current instruments shall be true rms types.

5. PREPARATION FOR DELIVERY

5.1 General.- All components that form a part of a particular system and are tested together shall be shipped together except when contract calls out components as separate line item deliverables, then shipment shall be by individual components. Each system or component shall be prepared for domestic shipment in accordance with the following subparagraphs.

5.1.1 Packaging.- Packaging shall be in accordance with specification MIL-E-17555. All loose items shall be securely fastened prior to shipment.

5.1.2 Packing.- Packing shall be in accordance with specification MIL-E-17555, level A.

5.1.3 Marking.- All shipments and packages shall be durably and legibly marked with the following instructions:

Quantity _____

Type _____

Style _____

Specification Number _____

Contract Number _____

National Stock Number _____

Manufacturing Name or Trademark _____

6. NOTES.- The contents of the subparagraphs below are only for the information of the Contracting Officer. They are not contract requirements, and are not binding on either the Government or the contractor except to the extent that they may be specified elsewhere in the contract as such. Any reliance placed by the contractor on the information is wholly at the contractor's own risk.

6.1 Deliverable items.- The following items are to be called out in the contract documents as deliverable items under this specification:

(a) Switch assembly panel, type I

(b) Switch assembly panel, type II

(c) Switch assembly panel, type III

(d) Switch assembly panel, type IV

(e) Switch assembly panel, type V

(f) Switch assembly cabinet

(g) Encoder interface unit

(h) Transmitter

(i) Transmitter antenna

(j) Receiver

(k) Receiver antenna

(m) Decoder

(n) Site spare parts for each unit of equipment

(p) Instruction book, draft manuscript

(q) Instruction book, final manuscript

(r) Over-age stress reliability prediction

(s) Detailed stress reliability prediction

(t) Early design maintainability prediction

(u) Final design maintainability prediction

(v) Quality Assurance test procedures

6.2 Scheduled events.- The following scheduled events are to be included in the contract: (a) preliminary design review and (b) critical design review.

6.3 Provisioning documentation.- Provisioning documentation, when required by the contract, shall conform to FAA-G-1210.

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